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LIGATION

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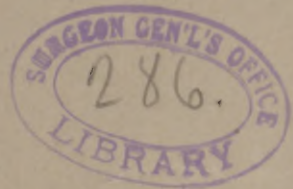
VERTEBRAL ARTERIES

FOR THE

RELIEF OR CURE OF EPILEPSY,

BY

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Read before the Chicago Medical Society, July 19th, 1886.



LIGATION OF THE VERTEBRAL ARTERIES FOR THE RELIEF OR CURE OF EPILEPSY.

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By J. L. GRAY, M. D., CHICAGO.

The question of the value of surgical interference in the treatment of epilepsy is one that has never been fully settled. It is true that, where depressed bone is found as a cause of the epilepsy, no one at the present time questions the necessity of relieving the pressure. But in the class of operations for the relief of the disease to which I am to call your attention, opinions are at wide variance. The majority of surgeons, I think, look upon the operation of ligating one or more of the large vessels furnishing blood to the brain as a sort of experiment to which recourse may be had in bad cases, but with no certain prospect of benefit to the patient. In the present paper it is my purpose to direct your attention to some of the points relating to the operation of ligating one or both of the vertebral arteries for the relief or cure of epilepsy.

I do not intend to enter into an extended discussion of the ætiology or pathology of epilepsy, but shall confine myself to a simple statement of such facts regarding the anatomy and physiology of the structures thought to be intimately concerned in the disease, and give only such general conclusions regarding its pathology, as are necessary aids to a proper estimate of the utility of the operation.

The ligation of the large vessels furnishing blood to the brain, for the specific purpose of relieving epilepsy, was first proposed in 1831, I believe by a Dr. Brown, of Calcutta, in a paper published in the *Calcutta Medical Journal*, though I am informed, that, prior to that date, the operation was performed successfully in this country by a surgeon upon his colored servant. This case, however, is not on record.

But from that time up, until a very few years ago, the carotids have been the arteries upon which the operation has been performed. In many cases, the ligation of the carotid has been of decided benefit in reducing the number and severity of the attacks, and, in a few instances, a complete recovery has been effected.

The operation for ligating the vertebral arteries to control the epileptic seizures was first advised, I think, by Dr. Wm. Alexander, visiting surgeon to the Liverpool Workhouse Hospital, in a paper published in the *Medical Times and Gazette* of London in 1881. Since that time the operation has been regarded with some degree of favor; but it still lacks much that is needful to place it among the recognized procedures which may be used in the treatment of a disease, which, perhaps more than any other, has tried the skill and baffled the treatment of medical men up to the present hour.

In order to fully understand the mode of action by which the operation is of benefit in relieving the epilepsy, it is necessary to recall certain facts regarding the anatomy and physiology of the structures thought to be concerned in the production of the disease.

The vertebral artery arises from the first part of the subclavian, passing through the foramina of the transverse processes of the cervical vertebræ, from the sixth upward. On account of the width of the atlas, the vessel, after passing through the transverse process of the axis, is directed obliquely upward and outward across the inferior articular process of this bone. It enters the corresponding foramina of the atlas, and appears on the upper surface of the posterior arch of this bone, where it lies nearly horizontal in a deep groove, and winds abruptly round the posterior edge of the superior articular process. Thence it enters the cavity of the cranium to pass forward and upward at the side of the medulla, between the olivary body and the anterior pyramid. It soon passes beneath the medulla toward the median line, where it joins the artery of the opposite side, at the spheno-occipital junction, to form the basilar artery.

Upon the posterior arch of the atlas, the artery occupies a triangle, of which the inferior oblique muscle forms the base, the superior oblique and the rectus posticus major the outer and inner sides respectively. Beneath it, on the groove of the atlas, is the first occipital nerve. At

the transverse process the rectus capitis lateralis separates the vessel from the occipital artery.

Before entering the transverse processes of the vertebræ, the artery lies to the outer side of the common carotid. It lies in the triangular space of which the subclavian is the base, the anterior scalenus muscle the lateral, and the longus colli the median, border.

The internal jugular vein is in front, and behind the artery is the inferior cervical ganglion of the sympathetic.

During its course through the transverse processes of the vertebræ, the artery is surrounded by filaments of the sympathetic nerve; the vertebral vein lies in front of the artery, while behind it are the nerves tributary to the cervical plexus on their way to the intervertebral foramina.

The vertebral arteries, with their branches, furnish the blood supply of the medulla, pons, cerebellum and posterior third of the cerebrum, while the carotids furnish the blood supply for the anterior two-thirds of the cerebrum.

The nerve supply of the great vessels going to the head is very intricate and profuse; the three cervical ganglia of the sympathetic are situated opposite the third, fifth and seventh cervical vertebræ. They have numerous filaments communicating above with the cranial and cervical nerves of the cerebro-spinal system. Branches also pass from the superior ganglion situated opposite the third cervical vertebra to the internal carotid, forming, in part, the carotid and cavernous plexuses, and branches also pass from this ganglion to the cranial ganglia. These ganglia also send filaments which unite with branches of the pneumogastric and glosso-pharyngeal, forming the pharyngeal plexus; and plexuses are also found on the external carotid, the vertebral and the thyroid arteries, following their distribution.

Three cardiac nerves also rise from these cervical ganglia of the sympathetic. These ganglia, with the filaments which are distributed to the various vessels about and within the head, contain the vaso-motor nerves for the vessels in question. That these filaments do contain vaso-motor nerves, is shown by section of the sympathetic. If the sympathetic be divided, dilation of the vessels results, with a marked elevation of the temperature. If the divided ends of the sympathetic be stimulated by a galvanic current, contraction of the vessels in the area to which the nerves are distributed results, while, if the stimuli be suffi-

ciently strong, a state of spasm of the blood-vessels is the result.

The relation between the sympathetic nerves and vertebral artery is very close indeed, and, during its course through the transverse processes of the vertebræ, the artery is surrounded so closely by fibres of the sympathetic that they can not be isolated without injury to its coats.

These points in regard to the anatomy and physiology of the nerve supply of the vessels in question have been dwelt upon thus fully, because they have a distinct bearing upon the utility of the proposed operation, and, still further, upon the location where the ligature should be applied.

The two principal factors in the classical attack of epilepsy are loss of consciousness and the convulsive disorder. The latter condition I do not propose to discuss: the former, that is, loss of consciousness (without which no true epilepsy can exist) is in all probability due to sudden contraction of the blood-vessels distributed to the posterior third of the cerebrum and the cerebellum. This spasm is reflex in its origin, the irritation causing the contraction being, in all probability, in the great vaso-motor centres in the medulla oblongata.

It is generally admitted, I think, that the real seat of local disease in epilepsy is in the great group of centres in the medulla, more especially the vaso-motor centres and the regions closely related thereto, as, for example, the convulsive centre pointed out by Nothnagel. The exact character of this disease is not well understood at present; but it consists, essentially, in some peculiarity of development or abnormal irritability of the centres in question to impressions received from without. This local disease, once present, it is probable, continues through life, and is of such an enduring character that it is capable of transmission by heredity.

Besides this local disease in the medulla, there is weakening of the inhibitory power, or power for control, in the brain.

Supposing, then, this local disease to be present in the medulla, as already stated, and once present to continue throughout the life of the individual, how may we explain the phenomena of an attack of epilepsy? In other words, why is it that, with local disease in the central nervous system always present, there are no constant symptoms of that disease?

It is true that we may believe the local disease to be always present in the centres in question in the medulla in a case of epilepsy; but the morbid excitations which arouse these centres to unhealthy action must come from regions outside the centres themselves; that is, the local disease may be present for years, and yet no fit occur, provided stimuli of sufficient intensity to rouse the centres to unhealthy action are prevented from reaching them.

In the vast majority of cases of epilepsy, the excitations which give rise to the attack start in some part of the digestive tract from the mouth down, or in the genito-urinary apparatus. These excitations are propagated by way of the splanchnic and pneumogastric nerves, as well as other portions of the sympathetic, up into the medulla, there to excite to unhealthy action the abnormally irritable centres situated in its depths. These excitations are thence transmitted outward along vaso-motor nerves which go to the vessels of the head, and contraction, or spasm, takes place, with the result that the patient loses, for the time being, consciousness. Excitations may come from other regions of the body, as, for example, from the brain itself; but, in the majority of cases, as already said, the excitations start in some region of the body below the level of the atlas or axis.

Such, in mere outline, is the mechanism through which unconsciousness in an attack of epilepsy is produced. Any measures therefore, which can be adopted to render the centres in the medulla less sensitive on the one hand, and, on the other, prevent unhealthy excitations reaching them, will go far toward rendering the individual free from the attacks. There are two theories which have been advocated in support of the benefit to be derived from ligating the vertebral arteries for the relief of epilepsy. The one which was first proposed, is that held by Alexander. In brief, his theory is, that the operation is of benefit in modifying the circulation by diminishing the quantity of blood sent to the diseased and hyper-sensitive centres.

He says "the epileptic centres may be rendered hyper-sensitive through some powerful shock. The circulation is, in many cases, restored to the normal, and the hyper-excitability is shown by only one fit or a series of fits.

"In other cases the hyper-sensibility exists, but only produces epileptic attacks in consequence of peripheral excitement, etc."

A full exposition of the views of Alexander, who has, perhaps, performed the operation more often than any other man, have been so fully set forth in articles in the *Medical Times and Gazette*, *Brain* and the *Medico-Chirurgical Review*, as to make it unnecessary for me to restate them. But, as already said, the principal effect which he considers to be produced is a modification of the quantity of blood distributed to the centres in the brain and medulla. There are several objections to the adoption of this theory of the modification of the blood supply to the parts of the brain and central nervous system in which the disease is.

There can be no doubt that ligation of both vertebrals produces a profound effect upon those portions of the brain and medulla supplied by them; but that effect is not, in my judgment, sufficiently permanent to account for the cessation of the attacks.

First of all, after ligation of both vertebrals, the part of the brain which had been supplied with blood by these arteries receives its blood supply from the carotids through the posterior communicating arteries of the circle of Willis. It is probable, that, within a very short time, these communicating arteries dilate to such an extent as to allow of nearly as great a blood supply to the posterior third of the cerebrum as it received before the ligation of the arteries. It does not, as Alexander leads us to suppose, take months or years to have the collateral circulation established. If this were the case, we should observe those symptoms which accompany cerebral anæmia; for, after ligature of the vertebrals, the posterior third of the cerebrum can only receive blood through the posterior communicating arteries, and they must of necessity enlarge in order to maintain functional activity of the region of the brain in question. But, as a rule, in cases in which the operation has been performed, no evidence of anæmia is observable immediately after the operation.

In the second place, if the benefit derived is due to diminishing the blood supply to the brain, the operation ought to prove of as great benefit in those cases where the excitation starts in the cortex and is propagated downward into the medulla as in those cases where the excitation arises in some region outside the central nervous system,—say in the digestive tract. But such is not the case. Thus far, I believe, the operation has proved of no benefit whatever in those cases of epilepsy due to cortical disease of

the brain, or where the attack is produced by strong emotional excitement of any kind.

The second theory upon which the operation has been recommended is that proposed by Dr. Jewell, of this city. He says: "The mere tying of the blood-vessel itself has never appeared to me to be a rational procedure; for the blood supply to the brain, derived from one of these blood-vessels, is speedily made good through the free anastomoses of cerebral and cerebellar arteries in the circle of Willis and its accessories. Any good done by these operations can not depend, therefore, on cutting off blood supply for any considerable length of time from those parts of the brain supplied by the ligated vessel. According to my view of the pathology of epilepsy, it is, in great measure, a disease of the vaso-motor division of the nervous system, particularly involving, directly or indirectly, those great centres of the nervous system that lie at various heights in the medulla.

"Vaso-motor nerves pass out from the vaso-motor centres involved in disease in epilepsy, and these, at the time of the attack, are the pathways of intense discharge to the small muscular arteries of the blood-vessels to which the nerves in question may happen to go, and the contractions and enlargements of which these arteries control. My belief is, that, at the time of the attack in typical epilepsy, loss of consciousness is due to sudden vasa spasm within greater or less areas of the brain, more particularly of its cortex.

"In this way is consciousness lost not only, but the inhibitory power of the brain over reflex activities accomplished through the gray spinal axis is left to play without needful control, such as is exercised by the cerebrum during the waking state. My opinion is, in respect to these operations, that they do good only when the nerves are tied that accompany the vessels. In this way are the vessels that are finally distributed to the brain itself, cut off from communication with the tricky, unstable centres of the medulla, just as a muscle is made to cease its spasm or irregular movements by dividing its motor nerve. In so far as the nerves can be included in the ligature, and completely cut off or severed, ought the operation to be successful, theoretically speaking.

"From what we know at present of wounds of the sympathetic, and of experimental wounds done to portions of the same in the lower animals, it would seem that a firm

physiological basis is laid for basing this doctrine. I have been led to believe that it is more important to tie the vertebral than the carotid, because the former supplies more directly the cerebrum and the medulla itself, and, so far as now appears, most of that portion of the brain in which the co-ordinating apparatus of the nervous system must culminate. They also supply, to no small extent, the great sensitive regions of the cortex of the brain. Running up, as they do, through openings in the transverse processes of the vertebræ, they are pretty closely invested with an intertwining network of vaso-motor nerves. When it can be determined, as is often impossible, which half of the brain is first invaded during an attack, the blood-vessels supplying that side of the brain are the ones chosen for ligation. In such cases, I have come to believe that both the carotid and the vertebral should be tied on the same side, if not at the same operation. But in other cases, in which the invasion is evidently bilateral, the operation, to be successful, if at all, should be done on both sides. But, in either case, in intractable examples of the disease, the operation, in my judgment, is justified for both sides, and at different times, for the vertebral arteries.

"Guided by theoretical considerations, I have recommended the operations done as high up as practicable."

The question as to the best place to ligate the artery in view of all the facts, is not an unimportant one. Dr. Alexander has operated at the sixth cervical vertebra. His mode of operating is as follows: "A linear incision commencing opposite the lower end, and on the outer side, of the external jugular vein, and about an inch above the clavicle, is carried upward for three inches along the external border of the sterno-mastoid. The layers of fascia are cut through, to the same extent, until the fatty tissue over the anterior scalenus is reached. With the finger the sulcus between the anterior scalenus and the longus colli can be opened up, and the sixth cervical vertebra reached by judicious teasing with a strong blunt probe or director. The artery will be generally easily found, provided no veins are injured. If the vessel is not found there, it will be found running up to the inner side. The sterno-mastoid and the external and internal jugular veins should be well protected and retracted by good retractors during the operation."

If the artery is ligated at this point the communication between the middle and superior cervical ganglion of the

sympathetic and the medulla is not severed. This allows morbid excitations to reach the medulla through the carotid and cavernous plexuses and the pneumogastrics,—a fact that should not be lost sight of if the theory of Dr. Jewell is adopted.

The high operation, so called, seems to be the preferable one if we wish to sever, in the most complete manner, communication through the sympathetic between the peripheral nervous system and the excitable centres in the medulla. Between the axis and atlas, Dr. Fenger's mode of operating is as follows: "The patient is placed on his side, with the head turned to the opposite side from that on which the operation is performed. An incision is made from the mastoid process perpendicularly downward three inches through the skin down to the sterno-cleido-mastoid. This muscle, together with the splenius capitis and longissimus capitis, is divided by a blunt instrument until the transverse process of the atlas is felt. This process, with the transverse process of the axis, is laid bare, and, if the latter is especially prominent, it is nipped off with bone forceps. The fibres of the oblique capitis inferior are then separated by a blunt instrument, and immediately below it we find the artery at its backward and outward convex arch, accompanied by its vein, and imbedded in a small amount of connective tissue. It is needful to carefully isolate the artery, because the vein is very easily torn, and the ensuing hemorrhage makes it exceedingly difficult to bring the artery into view that the ligature may be passed. In passing the needle very great care is necessary, for the position of the artery is such that the concave side of the arch is very close to the bone; and it is only with difficulty that injury to the coats of the artery by the needle pressing against the body of the vertebra, is prevented. It is best to ligate double; but it is doubtful if the artery should be cut, on account of the comparative ease with which the ligature may slip in this position.

Dr. Alexander has reported (in *Brain*, July, 1882), twenty-one cases in which the operation has been performed. These cases were all inmates of the Liverpool workhouse, and were of the most aggravated character. At the time of the report of these twenty-one cases, three had been quite well for nearly a year, nine others were so free from fits for such a space of time that it might be said a cure would probably result, and eight improved to such an extent that

the operation would be justified were no better results ever obtained. One case, a little girl, died from septic poisoning.

In this city the operation has been performed seven times. Dr. E. Andrews, in 1883, ligated the right vertebral between the atlas and axis in a man aged twenty-two, who had had epilepsy for five years, apparently as a result of severe mental shock. He had from twelve to fifteen attacks in twenty-four hours at the time of the operation, and was insane. Eleven days after the operation the patient left the hospital. After the operation, during a period of three weeks, he had only one fit. Since that time his mental condition has much improved, and the attacks, if they occur at all, are much less severe than prior to the operation.

In the "Transactions of the Illinois State Medical Society for 1885," Dr. D. R. Brower reported the case of a child, six years of age, who had the first fit during dentition, the next one in about 6 months, and since then more frequently until they averaged one in five days. They had stopped the development of the mind, so that the child was an imbecile. The artery was tied between the axis and atlas, on one side, and five weeks after the operation there was every evidence that it had been beneficial to the child.

Dr. Fenger has performed the operation three times, the first two cases being patients of Dr. Jewell. The first, a man aged twenty-seven, married, was first seen September 20, 1883. He had had epilepsy for over two years. He had had a cut on the forehead at the root of the nose, and had been shot on the middle of the nose. He had had both the petit mal and the grand mal, the attacks varying in number from one in six months to two in a single day. A diagnosis of cortical epilepsy was made, the usual treatment with bromides was advised, with no marked benefit, and the operation was suggested. The right vertebral was ligated between the axis and atlas, and an attempt was made to ligate the left; but there was some anomaly in the course of the artery, so that it could not be found. For a time after the operation, the patient was much improved; but, from a recent report, I learn that his condition is not perceptibly improved to what it was before the ligation of the artery. The second case was that of a young lady who had been subject to nocturnal epilepsy for years. Every form of

medication seemed to be of no benefit in relieving the disorder. As a last resort she begged to have the operation performed. Dr. Fenger ligated the left vertebral between the axis and atlas. Within twenty-four hours after the operation she commenced to have violent borborygmi, and soon after bloody dysentery set in. The abdominal symptoms did not yield to any treatment which was advised, and the patient died on the third day after the operation. In connection with this case it should be stated, that, through the mistake of an attendant, an over-dose of chloral was administered; but whether this had any effect upon the final termination of the case, I know not.

The third case was a patient in Cook County Hospital. He had had epileptic fits for fifteen years. Three months before operation, while under the influence of bromides, he had one fit every day. During the three weeks prior to the operation, he had four attacks. On June 9, both the vertebral arteries were ligated between the axis and atlas, and tied double, but not cut. On June 12, he was dressed by Dr. Bernauer, and at six o'clock he suddenly got out of bed and attacked a patient in the next cot, and had to be put back by force. The patient said it was an epileptic fit. On July 9, he left the hospital, having had five attacks since the operation.

The operation has been performed twice since in the County Hospital; but sufficient time has not elapsed to enable us to judge of the results.

The artery has been tied once in St. Louis and once in Louisville; but the operations were done so recently as to make it impossible to form any conclusions regarding the benefit to be derived.

The operation thus far has not in this country been performed a sufficient number of times to allow any sound conclusions to be drawn. The reports of Dr. Alexander are certainly encouraging, giving, as they do, the results in the most intractable cases possible to imagine. From all the evidence at hand, I think we may draw the following conclusions:

1. Ligation of the vertebral arteries should take its place as a recognized procedure in the treatment of certain cases of epilepsy.

2. The operation should be confined to those cases in which the exciting causes of the attacks come from some region outside the brain.

3. The arteries should be tied as high up as practicable, and the ligature should include all the fibres of the sympathetic accompanying the vessel.

4. Where the side of the brain which is first invaded by the disease can be determined, the artery of that side should be ligated.

5. Where the invasion of the disease is apparently bilateral, both vertebrals should be ligated.

6. This operation should not be done as a substitute, but as an aid to other forms of treatment for the relief or cure of epilepsy.

In the preparation of the present paper, I have received many valuable suggestions from Dr. Jewell, and could not have had access to all the literature on the subject but for his kindness in allowing me the free use of his library. I have also had many valuable suggestions from Dr. Fenger regarding the surgical phase of the discussion.

